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A Riview Of The Principles And Applications Of Sound Wave

[1]zakar Muhammad And [2]dahiru Dahuwa

Abstract: *This research review of the principles and applications of sound wave it gives more emphasis on the principles of sound wave in relation to Physics. The research discussed the characteristics of sound wave, methods of sound propagating, relationship of sound wave to ear hearing, medium where the wave is propagating as well as the various applications of sound wave.*
Key words: *sound wave, Resonance, Interference, Diffraction and application of sound*

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I. Introduction

One of the most commonly observed types of wave is that called a sound wave. By means of a sound wave, minute amount of energy are carried to our ears and stimulates sensation of sound. Usually, the medium that transmits this wave is the air surrounds us, despite the fact that the waves are transmitted by air and other gases which gives an immediate vibration as the kind of wave that comes to the ear. Sound is a pressure waves that consists of tiny fluctuations in the air pressure. Three elements are necessary for the production of a sensation of sound (i.e., vibrating source, transmitting medium and the receiver). Vibrating source, which in its vibration supplies energy to the surrounding medium, the medium transmit this energy from the source to the receiver by means of a sound wave. When the wave arrives to a receiver, energy is transferred to the receiver, if the receiver is an ear a sensation of sound may be produced [1].

Important terms to describe sound

Amplitude: In general, the amplitude of a sound wave is the maximum change of a parameter during the oscillation of a wave. However, this parameter could usually be as a result of pressure produce in the course of propagation. The amplitude of a sound wave is the loudness of the sound produced. In illustration, this is the distance between peak and trough.

Wavelength: Wavelength of a sound wave can be measured between any two of the same phase (crest or troughs). Thus, it's the spatial period of the wave where the distance over which the wave's shape repeats itself.

Frequency: The Frequency is defined as the number of vibrations, oscillation or cycles in a repeating process occurring per unit time. The unit of frequency is Hertz (Hz). The frequency of a sound wave is what we understand as pitch. A higher frequency has a higher pitch, and a lower frequency has a lower pitch. Consider the figure 1.0 below, sound A has a higher pitch than sound B. for instance, the chirp of a bird would have a high pitch, but the roar of a lion would have a low pitch.

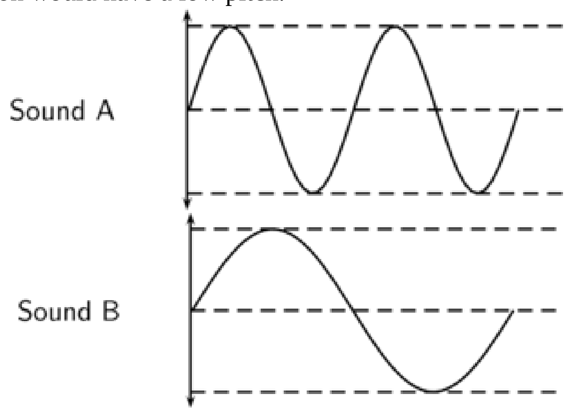

Figure 1: Pitches of a sound wave [12]

If a source of sound is directed at a vertical surface some distance away, an echo may be heard. Sound waves bounce up the vertical surface, and are reflected back towards the source. Reflection of sound waves obeys the laws of reflection [2].

Intensity: Intensity is the rate at which sound energy flows through a defined area. Since the flow of energy is power, its dimension however is power/area. Usually, sound intensity is measured in watts/meter^2. The intensity is however perceived as loudness.

AIM AND OBJECTIVES

The aim of this research is to explain the application of sound wave behind Physics to achieve the following objectives:

1. Sound in Medicine (Ultrasonography)
2. Sound in Technology (How to generate energy, weapon and more)
3. Sound in Geophysical prospecting

SOUND WAVE

Sounds are generally audible to the human ear with their frequency (number of vibrations per second) lies between 20 and 20,000 vibrations per second, but the range varies considerably. Sound waves with frequencies less than those of audible waves are called subsonic and those with frequencies above the audible are called ultrasonic [1].

Velocity of sound is not constant, because it varies in different medium and in the same medium at different temperatures as well. Sound travels more slowly in gases than in liquids, and more slowly in liquids than in solids. Since the ability to conduct sound is dependent on the density of the medium, solids are better conductors than liquids, and liquids are better conductors than gases. Besides, the speed of sound in a solid is varied with the speed of sound in a liquid as well as in gases [2].

A sound wave is usually represented graphically by a wavy horizontal line; the upper part of the wave (the crest) indicates a condensation and the lower part (the trough) indicates a rarefaction (Figure 2) This graph, however, is merely a representation and is not an actual picture of a wave. The length of a sound wave, or the wavelength, is measured as the distance from point of greatest condensation to the next following it or from any point on one wave to the corresponding point on the next in a train of wave [3].

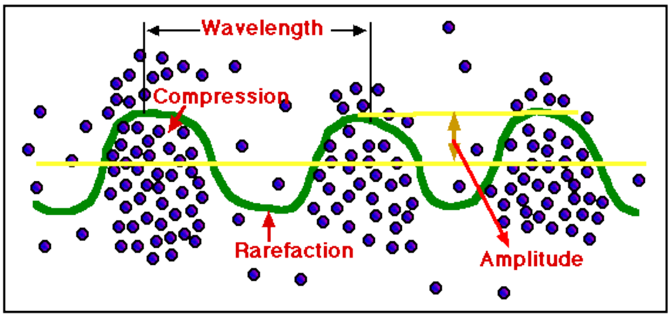

Figure 2: Representation of Sound wave [12]

II. Mechanical Waves

Sound wave can be in form of mechanical wave, it is a wave which requires a material medium for its propagation. Waves on a string or rope, water waves and so on, are examples of mechanical waves. Thus, mechanical energy (Kinetic energy, T, and Potential energy, V) passes from one part of the medium to another. Successive particles of the medium repeat the same set of movements with each beginning its movement a little later than the one before it [2]. Besides, mechanical wave has the following properties:

- Refraction
- Reflection
- Interference

Refraction

Sound waves can be refracted as well as reflected. Tyndall placed a watch in front of a balloon with carbon dioxide, which is heavier at definite place on other side of the balloon, which therefore has the same effect on sound waves as a converging lens has on light waves [2].

If the balloon is filled with hydrogen, which is lighter than air, the sound waves diverge on passing through the balloon. In this case, the gas balloon acts similarly to a diverging lens when light waves are incident on it [2].

The refraction of sound explains why sounds are easier to hear at night than during day time. In the day-time, the upper layers of air are colder than the layers near the earth. Sound travels faster when the temperature is high, also sound waves are refracted in a direction away from the earth. The intensity of sound waves then diminishes. For a similar reason, a distant observer at a point O hears a sound from a source more easily when the wind is blowing towards him than away from him (Figure 3) below. When the wind is blowing towards O, the bottom of the sound wave is moving more slowly than the upper part [3].

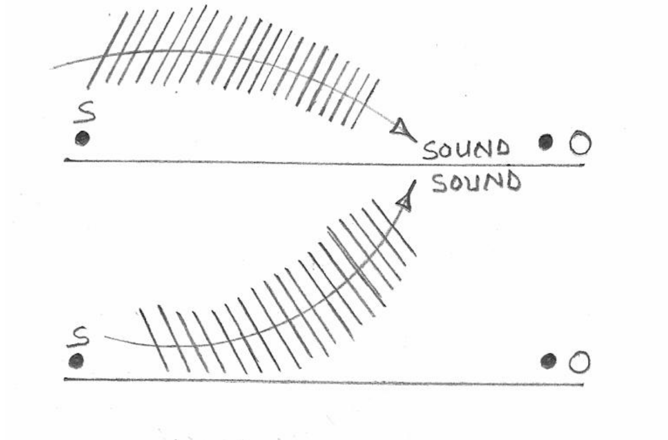

Figure 3: Refraction of sound wave [3]

Reflection

Sound waves are reflected from a plane surface so that the angle of incidence is equal to the angle of reflection [2]. This can be demonstrated by placing a tube T_1 in front of a plane surface AB and blowing a whistle gently at S, another tube T_2 directed towards N, is placed on the other side of the normal NQ, and move until a sensitive microphone connected to a cathode ray oscilloscope is considerably affected at R, showing that the reflected wave is in the direction NR. It will then be found that the angle RNQ = angle SNQ [2] (Figure 4) below.

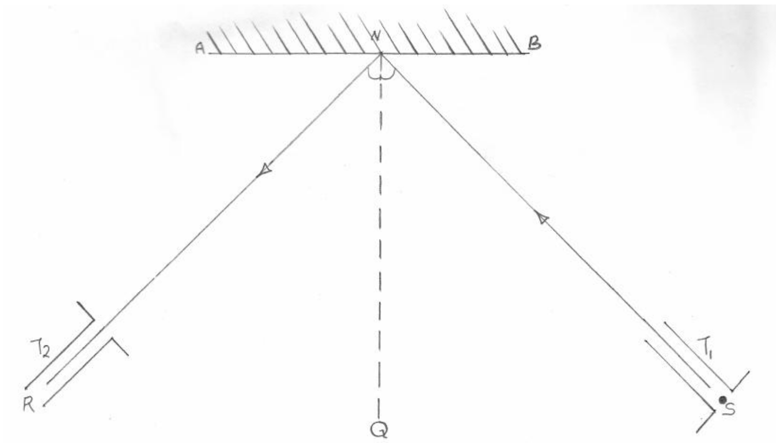

Figure 4: Reflection of sound wave [3]

Interference

When two or more waves of the same frequency overlap each other, the phenomenon is known as interference of waves [2]. Interference is easily demonstrated in a ripple tank, where two sources of wave A and B of the same frequency are used.

The interference pattern can be explained from the principle of superposition. If the oscillation S of A and B are in phase, crest from A will arrive at the same time as crest from B at any point on the line RS (Figure 5). So, along XY, however, crest from A will arrive before corresponding crests from B. in fact, every point on XY is half of wavelength, λ/2 nearest to A than to B, so that crests from A arrive at the same time as troughs from B, and the resultant is zero [4].

Generally, reinforcement (i.e., constructive interference) occurs at a point C when the path difference $AC - BC = 0$, λ or 2λ, and cancellation (i.e., destructive interference) when $AC - BC = \lambda/2$, $3\lambda/2$ or $5\lambda/2$.

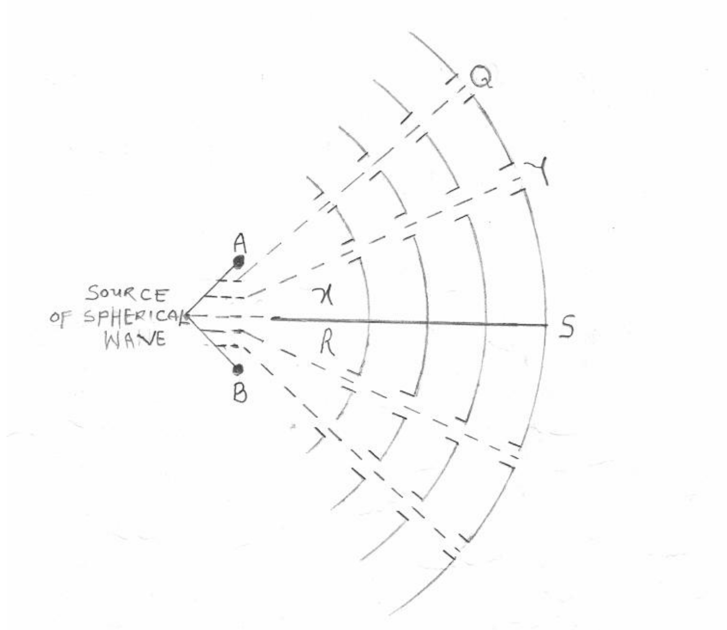

Figure 5: Interference of sound wave [3]

2.3 RESONANCE

Resonance occurs when a body oscillates at its own natural frequency as a result of the impulses it receives from another oscillating body of the system. The reinforcement of sound by resonance with its accompanying release of large amount of energy has many useful and many obnoxious consequences [4], such as the resonance of the air column in audible sound of the vibrating air jet. However, resonance of a radio and loud speaker to a certain frequencies would produce an objectionable distortion of speech or music. An object that has the properties of inertia and elasticity may be set into vibrations. Most bodies may vibrate in more than one mode and for each of these modes of vibration, there is an associated frequency. In each of these modes of vibration, a set of standing waves is set up by the body. Such standing waves may be transverse or longitudinal depending upon the shape and the characteristics of the vibrating body.

Besides, there are three different types of resonance based on their oscillating and vibrating media and the system causing them, these are:

i. Mechanical Resonance: Occurs when a body is set into oscillation by mechanical system, it oscillates at a natural frequency equal to that of the mechanical system.
ii. Acoustic Resonance: Occurs when an air medium acquires a natural frequency which is the same as the frequency of another oscillating system producing it.
iii. Electrical Resonance: Occurs when the current flowing through a conductor oscillates at natural frequency due to the impulse.

2.4 TRANSMITTING MEDIUM

The motion of vibrating source sets up waves in a surrounding elastic medium. When the vibrating source is transverse or longitudinal, the wave set up in the surrounding medium is a compression wave, whose frequency is the same as the frequency of vibration source. Besides, if the frequency is within the range to which the ear is cognizance up, the wave is a sound wave. However, sound wave involves compression of some materials, which can be transmitted only through a material medium having mass and elasticity. In addition, no sound can be transmitted through a vacuum [3].

SPEED OF SOUND IN A MEDIUM

The speed of sound depends on the density and elasticity of the medium, which means that the speed varies from medium to medium. The speed of sound in air is about 332 m/s at ℃. Besides, the speed of sound is defined as the speed at which an observer must travel, so that the wave pattern appears stationary to him. It thus have a unit of meter per second (m/s), the speed of a mechanical wave through a medium is governed by the inertia of the oscillating particles of the medium and also by the elastic properties of the medium [4].

The speed of mechanical waves is given in general as;

$$Vm = \sqrt{\frac{Elastic\ \ property}{Inertia\ \ property}} \qquad (1)$$

Where, Vm is the velocity or speed of mechanical wave

Moreover, sound wave can be transmitted through the following medium:

- Solid
- Liquid
- Gas

Speed of Sound in a Solid

The speed of sound in a solid (i.e. longitudinally in solid rod) is thus represented mathematically as;

$$v = \sqrt{\frac{y}{\rho}} \qquad (2)$$

Where, y = Young modulus and ρ = Density of the solid. Young modulus y is defined as the ratio of stress to strain.
i.e.,

$$y = \frac{Stress}{Strain} \qquad (3)$$

For sound wave traveling through a medium;

$$v = \sqrt{\frac{Elastic\ property}{Density\ of\ the\ medium}} \qquad (4)$$

Speed of Sound in a Liquid

The speed of sound wave in a liquid depends on the liquids compressibility and inertia. If the liquid has a bulk modulus, B and density, ρ. Then the speed of sound in the liquid is represented as:

$$v = \sqrt{\frac{B}{\rho}} \qquad (5)$$

Speed of Sound in a Gas

The speed of sound in a gas depends on the change in the pressure of the gas which can either be isothermal or adiabatic. When this change occurs slowly, there is time for an excess heat to be conducted away and thus the temperature remains constant. Thus, the change is then isothermal (i.e. $PV = constan$). When this change occurs rapidly, then it's an adiabatic change (i.e. $PV^{\gamma} = constant$). Besides, the speed of sound in gases is in general given as;

$$v = \sqrt{\frac{\gamma P}{\rho}} \qquad (6\ )$$

Where, γ is a constant called ratio specific heat of the gas, P is the pressure of sound and ρ is the density of sound.
Move over, the velocity of sound in dry air is in general given as;

$$v = 331.4 + 0.6Tc\ m/s \qquad (7)$$

Where, v is the speed or velocity of sound, and $Tc,$ the Celsius temperature.
Therefore, the speed of sound in gas in general is a function of its temperature, the molecular structure of the gas and molecular mass.
The speed of sound for some gases at zero degrees Celsius (0^0 C) is given below:

Table 1: Speed of sound in some gases

Gas	**Speed (m/s)**
Air	331
Hydrogen	1290

RELATIONSHIP OF SOUND TO EAR HEARING

Our ears are extra ordinary organs, they picks up all the sound around our environments and then translate this information into a form that our brains can understand. One of the most remarkable things about this process is that, it is completely mechanical. When sense of smell, taste and vision all involves chemical reactions, the hearing system is based solely on physical movement [5]. To hear sound, the ear mechanism has to do three basics things. These are:

a. Direct the sound wave into the hearing part of the ear, as the fluctuations is the air pressure.
b. Translate these fluctuations into an electrical signal that the brain can understand. The pinna which is the outer part of the ear, serves to catch the sound waves.
c. The outer part of the ear is pointed forward and has a number of curves. These curves help to determine the direction of the sound.

Once the sound wave travel into the ear canal, they vibrate the tympanic membrane, commonly called the ear drum**.** The ear drum is a thin cone-shaped piece of skin, about 10 mm (0.4 inches) wide. It is located between the ear canal and the middle ear. The middle ear is connected to the throat via the Eustachian tube [5]. Since air from the atmosphere flows in from the outer ear as well as the mouth, the air pressure on both sides of the ear drum remains equal. In addition to protecting the ear, this reflex helps to concentrate the hearing. It masks loud low-pitch back ground noise so you can focus on higher-pitch sounds [6]. Among other things, this also helps to carry in a conversation when in very noisy environs.

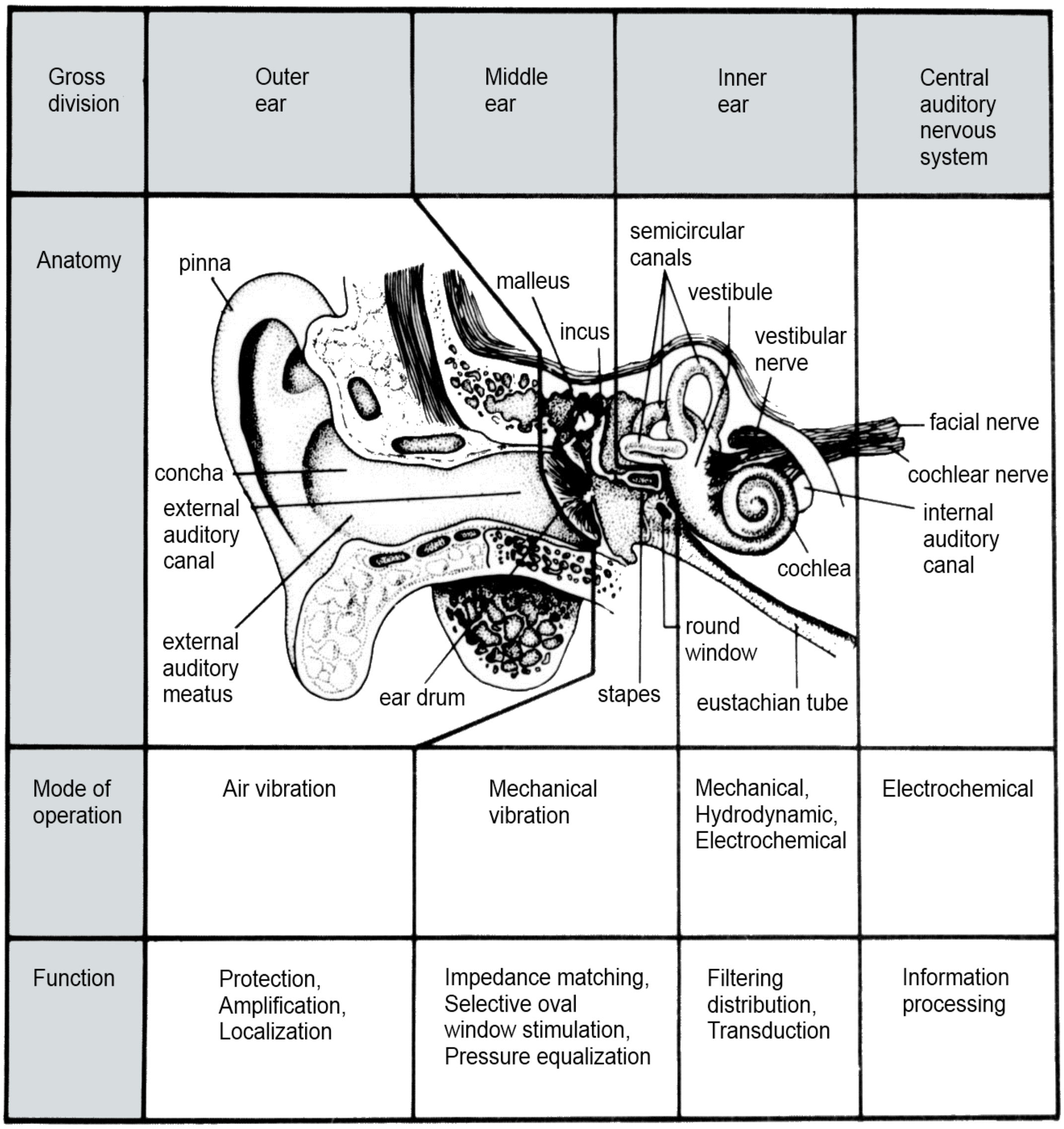

Figure 6: Cross-section of the human ear [12].

III. Applications Of Sound Waves

Sound waves have many applications in science and medicine. Ultrasound imaging can be used to investigate medical problems and carry out important checks. One well-known application is an ultrasound scan, used to produce an image of an unborn child, in order to check on its health where an X-ray would not be safe. Sound pulses, known as sonar, can be used to map the ocean floor by precisely measuring the time taken for an echo to be received [2].

APPLICATIONS OF SOUND WAVES IN PHYSICS PERCEPTION

There are various types of applications of sound waves regarding to physics perception, among which includes;

- Ultrasonic
- Acoustic of buildings
- Geophysical prospecting

- Sound production
- E.t.c.

Ultrasonic

When a piece of quartz cut along certain axis is thus compressed, positive and negative charges are exhibited from its composite faces and the polarity of the charges reverses when the crystal is under tension, this is the piezo-electric effect. The alternate compressions and stretching of a compressional wave generate a small alternating potential across the crystal, which provides an effective means of detecting and measuring the wave.
Conversely, if we apply an alternating electrical potential to the quartz, it expands and contracts at the same frequency by an amount which increases with the potential. The amplitude of vibration of the quartz becomes large when the frequency of the alternating potential coincides with one of the natural modes of vibration of the crystal.

Originally piezo-electric transducers where cut from single crystals but more recently polycrystalline ceramic materials, such as barium titanate, have been used. The minute piezo-electric regions in the ceramic are normally randomly oriented but they can be lined up by the application of an electric field of about 3×10^6 v/m.

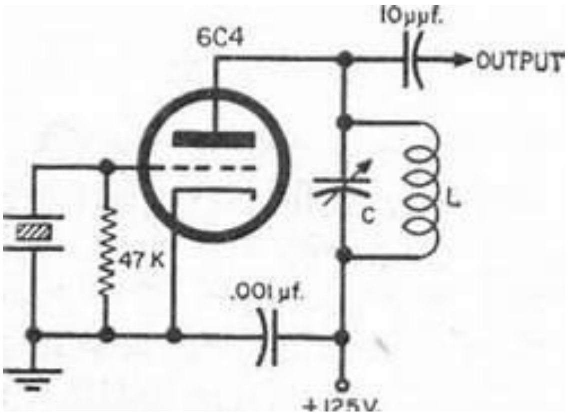

Figure 6: Circuit representation of crystalline quartz stimulation of ultrasonic sound wave [1].

Ultrasonic sound waves have many applications. One of the earlier ones was to improve depth sounding methods used by ships. The high frequency waves can be emitted in narrow beans and they are not absorbed by the water, so strongly as the lower frequency waves. This makes it possible to obtain a continuous record of the profile of the ocean floor. The waves can be used to use to transmit messages between submarines, and to serve in a similar way to radar in tracking under water craft and objects such as ice bergs.

Another application of the echo sound principle is the use of ultrasonic waves detected by the waves they reflect back to the detector.

The thickness of a metal plate at any point can be measured even when we have access to only one side. We measure the successive frequencies f_1 and f_2 of the transducers which produce resonance in the plate thickness, x (Figure 7).

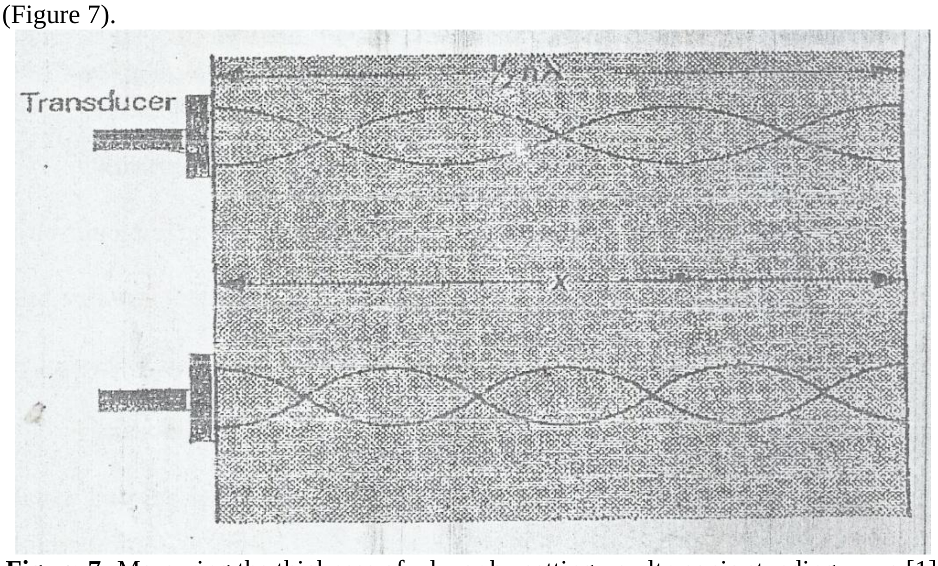

Figure 7: Measuring the thickness of a layer by setting up ultrasonic standing wave [1]

$x = \frac{n\pi^1}{2} = (n+1)\frac{\pi^2}{2}$ (10)

Also the velocity,

$v = f\pi$ (11)

$x = \frac{nv}{2f} = \left(\frac{n+1}{2}\right)\frac{v}{f_2}$ (12)

This method allow us to check the thickness of plates, pipes or sheathing, which are subject to corrosion and it has been used to measure the thickness of the fat layer of pigs. Square or other shaped holes can be bored into a surface if a hardened rod in contact with the surface, is subject to ultrasonic vibration. The cutting head does not rotate, rather vibrates with the help of abrasive and produces holes of the same shapes as the cutting head. Plastic compound can be welded together by ultrasonic vibration which produces heat through friction at the point of contact.

Ultrasonic wave in liquids produces cavity, which they produce tiny spaces in the liquid. The partial vacuum in these spaces exerts a small pull on exposed solid surfaces, detecting particles of dust which may be adhering to the pull. Even the insides of hypo dynamic needle can be cleaned up in this way. Ultrasonic in liquids may be used to emulsify immiscible liquids or to destroy bacteria by busting their cells.

These are some of the applications regarding to ultrasonic waves, produced either by pizza-electric transducers, such as quartz or else by Magnetostriction transducers, such as nickel or cobalt. Transducers of the latter type change their lengths when they are magnetized. And thus, in alternating magnetic fields, they vibrate in similar way to quartz.

Acoustic of Buildings

The study and design of building interior to produce specific listening conditions is called acoustic. W.C. Sabine, a Professor at Harvard University founded this study of acoustic so recent as the beginning of the country but, already acoustic ranks in the importance of lightening, ventilating and sanitation in building design.

The acoustic of building are closely linked with reverberation that is the persistence of a sound due to its repeated reflection from the boundaries of an interior. The time interval between the making of a sound and the movement when its reverberation just becomes in audible is the reverberation time. It is usually defined as the time in which a note of 512 Hz falls to 1 millionth part of its initial intensity. The reverberation time is almost zero in the open air when there is no reflection. It is several seconds in a large swimming pool and thus, sounds are in distinct been use of the overlapping of reverberations. The optimum reverberation time increase with the size of the auditorium, and is greater for orchestral music than it is for light music and speech. The ideal reverberation time thus, might range from half of a second for speech in a small school hall to $2\frac{1}{2}$ seconds for orchestral music in a concert hall [6].

Each time a sound wave is reflected, a fraction of the incident energy is absorbed by the surface. This fraction is the absorption coefficient $\propto$ of the surface.

$\propto = \frac{Absorbed\ \ energy}{Incident\ \ energy}$ (13)

The combined absorption, called the Sabine absorption a, of a number of surface is computed by adding the product of the surface area S_1, S_2, S_3 e.t.c. and their individual absorption coefficient $\propto_1, \propto_2, \propto_3$ e.t.c.

$a = S_1 \propto_1 + S_2 \propto_2 + S_3 \propto_3$ (14)

Sound is absorbed quickly in a small room where it undergoes many reflections in a short time. The reverberation time t, in seconds is given by the equation:

$t = 0.6\ \frac{Room\ \ temperature}{Sabine\ \ absorption}$ (15)

$t = 0.16\ \frac{v}{a}$ (16)

The equation holds when meters are used in the calculation of v and a (the equation is not dimensionally consistent as it stands because the factor 0.16 is inversely proportional to the velocity of sound).

The reverberation time of a room can be reduced by living the walls with cellular materials, such as cork, fiber or polystyrene, which responds to sound vibration converting it into heat energy (Table 3). These covering are used to prevent resonances in all coves or sound concentrations due to focusing by large curved surfaces. The acoustics of a room change according to the number of people present, because of the absorption of sound which the people produce. This is corrected by padding the seats to make their absorption coefficient about the same when empty as when occupied.

Table 3: Examples of some common surface of absorption coefficient

Surface	**Coefficient (α)**
Open window	1.0
Cellulose fiber tites	0.8
Felt	0.6
Heavy carpet	0.4

Heavy curtains draped	0.5
Acoustic plaster	0.25
Wood	0.03
Brick work	0.025
Concrete	0.02
Plaster	0.02
Glazed tiles	0.01

In the design of houses and flats, sound insulation is very important. Sound insulation problems are of two kinds;

i. The reduction in sound transmitted through the air of one room through a wall to the air of the next room.
ii. The reduction of the sound transmitted by the structure of the building itself.

The sound insulating effect expressed in decibels provided by a partition wall to air borne sound, increases uniformly with its weight. The insulating effect of light partition walls can be improved to some extent by the use of double layers separated by felt or by a wider layer (> 100 mm) of air.

Geophysical Prospecting

An earthquake or major explosion generates vibration waves which may travel very large distances through the earth. When these vibrations are recorded on seismographs at different places on the earth's surface, they can be used to detect and locate and classify the disturbances to give information about the structure of the earth [5]. The reflection of such waves through rock strata is used by geologists, prospecting for oil resources, and also locates depth of the structures likely to be found in the certain oil deposits (Figure 8).

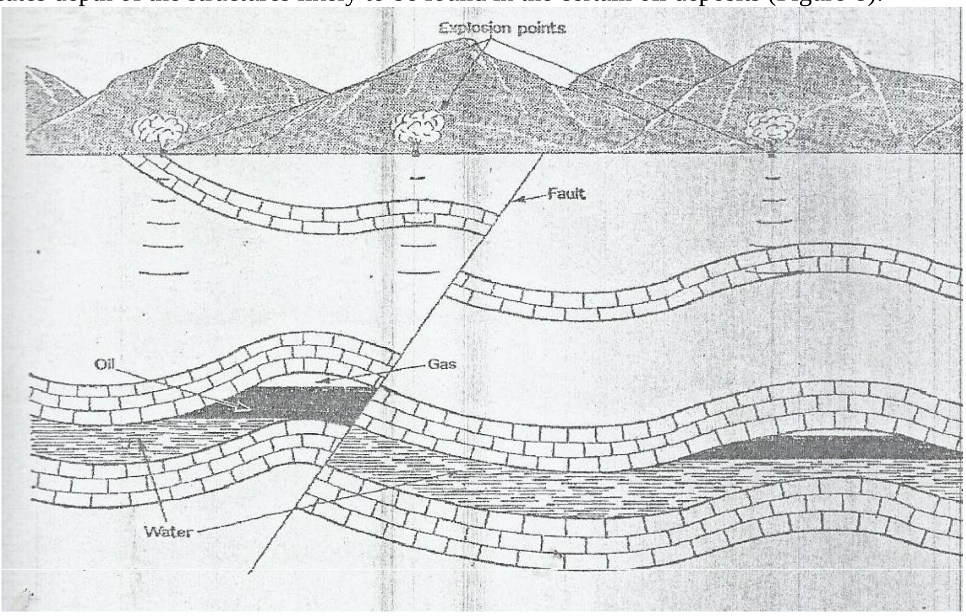

Figure 8: Oil prospectors plot the structure of the rock strata by timing the echoes of surface explosions [1]

Depth sounding of the ocean employs similar techniques. An instrument records the time between the sound and the return of its echo from the ocean bed, from the knowledge of this time and the velocity of sound in sea water, the depth can be deduced.

Sound Production

Any vibrating body whose frequency is within the audible range will produce sound provided that it can transfer to the medium, enough energy to reach the threshold of audibility. Even though, this limit is reached, it is frequently necessary to amplify the sound so that it will be readily audible where the listener is stationed. For this purpose, sounding boards and loudspeakers may be used, the purpose of each being to increase the intensity of the sound.

When a sounding board is used, the vibrations are transmitted directly to it and force it to vibrate. The combine vibrations are able to import greater energy to the air than the original vibration alone. If the sounding board is to repro duce the vibrations faithfully, there must be no resonant frequencies, for such resonance will change the quality of sound reduced.

The loudspeaker is to increase the intensity of sound sent out, either by electrical amplification or by resonance. Two general types are used, the direct radiator, such as the cone loudspeaker commonly used in radios and the horn type. The direct radiator is used more commonly because of its simplicity and the small space required. The horn speaker consists of an electrically or mechanically driven diaphragm coupled to a horn. The air column of the horn produces resonance for a very wide range of frequencies and thus increase the intensity of the sound emitted. The horn loudspeaker is particularly suitable for large-scale public address system [7].

SOUND WAVE IN ENERGY GENERATION

Built on the principle of 19th centuries, Rovert Sterling who discovered that cooling gases could derive a piston, the thermo acoustic striling heat engine produces sound from heated helium within the engine. The sound waves then derive a piston which in turn generates electricity. Sound is also being used more constructively promising to defeat noise pollution and even power engines in the future. Researchers working at the Los Alamos National Laboratory in New Mexico for instance, have developed what they claim is an environmentally friendly engine with no moving a part that is powered by sound waves [2].

SOUND WAVE IN PRODUCTION OF WEAPONS

To prove how potent sound waves can be a selection of unfortunate, laboratory animals were placed on the receiving end of this more sinister use of acoustic technology. When high-powered infrasound was directed at the subjects, it caused internal bleeding and even destroyed body tissue. This is a sound wave weapon [3]. Encouraged by the lab results, militarists around the world are working on such a sound arms, which they hope to put to use in conflicts. Cars create a great deal of the sound pollution to which we are exposed each day. A group of Japanese, Scientists believe that the solution to this is to fight noise with noise.

Japans Public Works Research Institute has unveiled a new kind of wall filled with a device that ameliorates high way and railway noise by overlapping its own sounds. The idea comes from the technology used in aero plane heat sets which also cancel out unwanted noise using noise [8].

The Institute of Cylindrical Active Noise Control (A.N.C.) measures the sound waves generated by traffic and then sports its own sound waves, whose peaks and troughs cancel out the peaks and through of the sound waves coming from the traffic. The result is listening of the tracked on our fomented ears, although the reduction achieve so far is only in the region of five percent (5%) [9].

SOUND WAVE IN MICROPHONE

Microphone converts mechanical sound waves into electrical impulses. The qualities we required in a microphone are:

i. A large electric out put
ii. The faithful reproduction of audible frequencies
iii. An absence of background noise

In the moving coil microphone, the pressure variation of the sound wave causes an identical vibration of the sound wave causes an identical vibration in a corrugated paper cone (Figure 8). The fire cool wound round the neck of a magnet generates a minute alternating current. At certain frequencies, the cone may resonate and produce unduly large output, while at high frequencies its output falls because of certain electrical effects. By skillful design, however, the resonant frequency of the cone can be made high and thus compensate for the reduced response at these high frequencies. The output of the moving coil microphone is weak but it matches closely the pattern of sound vibration [8].

In crystal microphone, the vibration of the cone is transferred to a piezo-electric crystal or to a ceramic material. The bending of the crystal produce a potential difference between its opposite faces, which fluctuates with the movement of the cone (Figure 9). The varying potential is picked up bimetal foil electrodes.

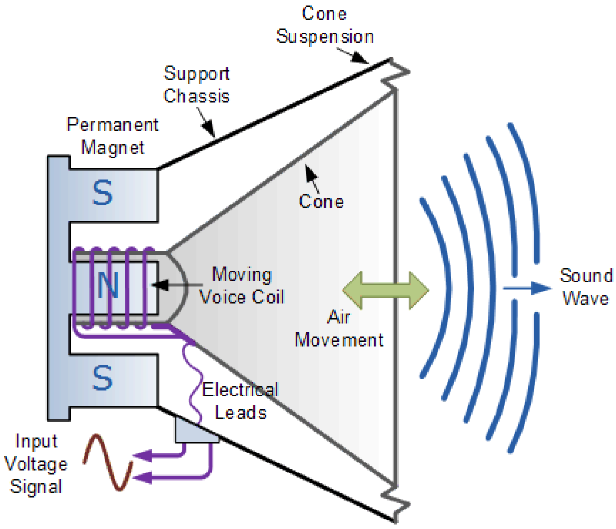

Figure 9: Cross section of Moving coil microphone [13]

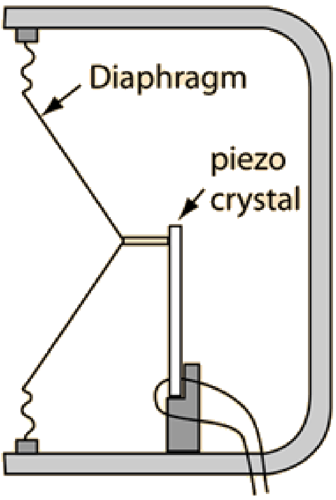

Figure 10: Crystal Micro-phone [13]

The electrical impulses produced by the crystal microphone do not correspond closely with the sound vibration. The cone and the crystal resonate at certain frequencies the output falls rapidly. The output frequencies is high, however there is needs of minimal amplification which is the reason why these microphones are so widely used.

The carbon granite microphone act in such a way that the variable resistance which respond to sound wave and modulate any current flowing through it. The pressure variation in the sound wave is communicated by a diagram to a volume of fine carbon grains (see Figure 11) This improves the electrical contact between grains at high pressure and the electrical resistance which allow a higher current to flow. The energy for this vibration comes from an externally applied e.m.f.

The electrostatic microphone is used by professional recording engineers because of its very uniform sensitivity range of frequencies.

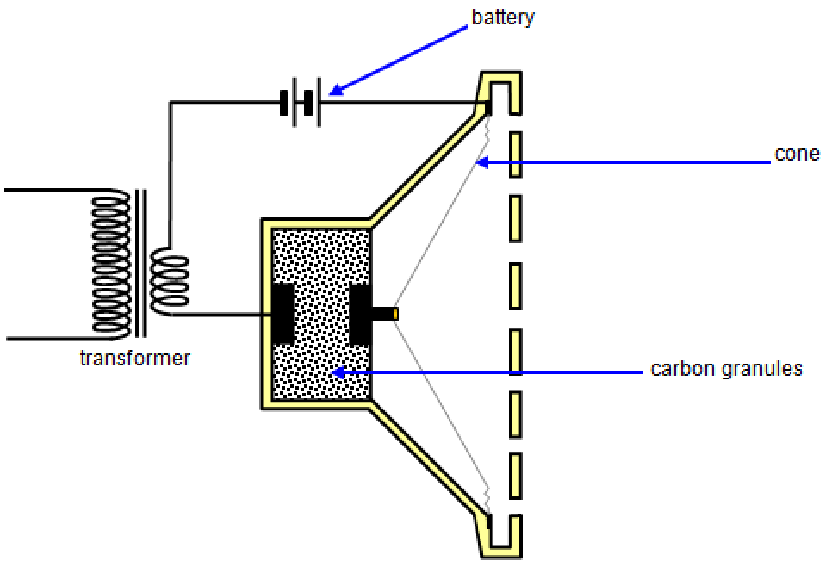

Figure 11: Part of Carbon granule microphone [13]

The Electrical impulse leaving the microphone is suitably amplified before being fed to a device for converting them back into sound vibrations. This is achieved by means of a speaker for a powerful and sound production or an earphone for individual listening. The moving-coil loudspeaker uses the principle of the moving-coil microphone in reverse. The alternating current in the feel to a coil situated in the field of a magnet and attached to a diaphragm (see Figure 12). This produces a vibration in the cone-shaped diaphragm which being large and can generates very intense waves.

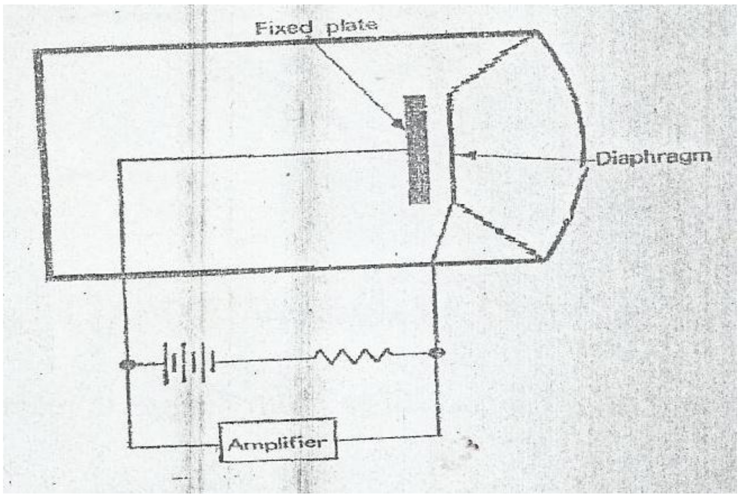

Figure 12: Part of Electrostatic Microphone [1]

The size of the diaphragm allows it to respond more easily to low frequency vibrations than to higher ones. To correct this, a small central cone is sometimes built into the large one, as in or separate smaller speaker is used [9]. When a compression is generated at the point in front of the diaphragm, a rarefaction is generated behind it (see Figure 13) and so, it prevent the mutual cancellation of these two disturbances, the speaker to resonate at certain frequencies can be reduced by mounting it in a cabinet whose dimensions suppress these frequencies and promote others [10].

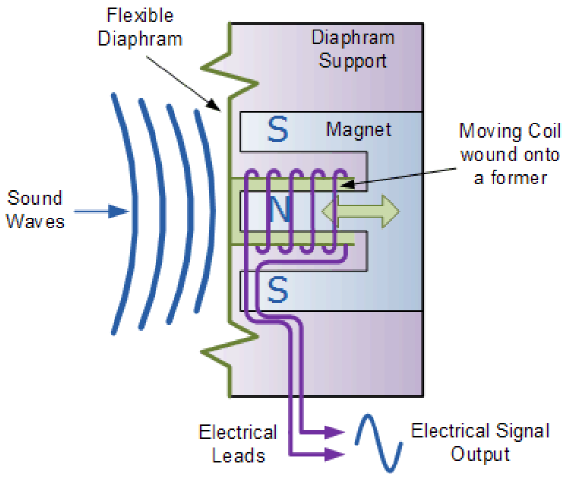

Figure 13: Part of Moving-coil Loudspeaker [14]

SOUND WAVE IN TELEPHONE EARPIECE

The incoming fluctuation current to the earphone passes through the windings of two electric magnets, causing their strength to vary. The permanent magnet at the base of the soft iron field pieces imposes on them a residual polarity, which can be increased or reduced by the current in the coils. If the polarity were allowed to reverse, the maximum attraction would occur at each peak of the current and the frequency would be double [8].

The diaphragm being small and stiffs responds more rapidly to the higher frequencies. This makes it more effective for the reproduction of speech, because the clarity of the speech increases when the frequencies below about 2000 Hz are absent. The diaphragm resonates at certain frequencies and does not reproduce accurately the wave form of the current input see (Figure 3.9). However, its ability to convert very weak currents into audible sound makes it suitable for use in telephone and radio headphone [11].

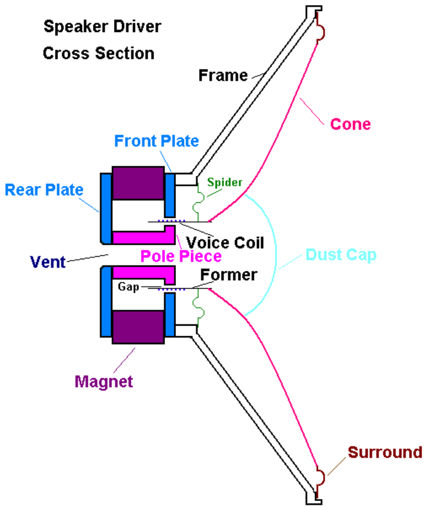

Figure 14: Cross section of telephone Earpieces [15]

IV. Summary, Conclusion And Recommendation

SUMMARY

Actually, this research was trying to evaluate the principles and applications of sound waves in relation to Physics.

In chapter one and two, we dealt with the principles of sound waves where we have seen that; Sound is a pressure waves that consists of tiny fluctuations in the air pressure which consists of intensity, amplitude and frequency. Mechanical wave; can be in form of refraction, reflection, interference and resonance. The velocity of sound; sound varies in different media in the same medium and at different temperatures (i.e. solid, liquid and gas) as well as Newton's equation and Laplace equation. The relationship of sound to hearing with ear; where mechanical wave carried into our ears and translate the information into a form due to the action of ear drum and then our brain understand.

In chapter three, we have seen the applications of sound waves where; sound is very essential to mankind, it is the basic of speak by which we can communicate ideas and information to one another. The various applications of sound waves which comprises of Ultrasonic, Acoustic of buildings, Geophysical prospecting, Sound reproduction, Sound recording, Sound production and Sound detectors.

Other applications of sound wave include the followings:

1. Energy generation: Cooling and heating gases could derive a piston, the thermo acoustic striling heat engines produces sound from heated helium within the engine. The sound waves then derive a piston which in turn generates electricity.
2. Producing weapons: When high-powered infrasound was directed at the subjects; it caused internal bleeding and even destroyed body tissue.

V. Conclusion

Based on the research conducted, the sound waves plays most important role in the field of Science and Technology. By considering the application like Ultrasonic; which is used in sounding methods in medicine, the measuring of metal plate thickness at any points and Acoustic of buildings which deals with the study and design of building interiors to produce specific listening condition e.t.c., it appears that considerable investigation remains to be done in this field.

Notwithstanding, the science of sound can be used in every day applications. The Physics of sound will continue to evolve (gradually and naturally) as human being continuous to advance in technology.

VI. Recommendation

In view of the application of sound wave development of science and technology, the following recommendations can be considered:

a) The Government should establish more research centers for the investigation of the applications of sound waves in different areas.
b) Universities should emphasize on conducting practical about the application of sound waves.
c) Researchers should be encouraged in the field of sound in order to discover more applications of sound waves.
d) Researchers have to make great awareness to people about the applications of sound wave.
e) Not all sounds are useful (i.e. Sounds from vehicles, industries, jets e.t.c.) have effects to human ear, so researchers should aware people about how to protect themselves.

Base on the above assumptions, if proper researches are conducted in the area of sound, more applications will be discovered.

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